Technical Note

Micron® Wire-Bonding Techniques

Overview

For more than 30 years, the semiconductor industry has used aluminum (Al) bond pads with gold (Au) wire to connect internal die to external packages. Micron is introducing a new nickel-palladium (Ni-Pd) bond-pad plating material that offers better long-term wire-bond reliability, can be used with a wider range of applications, and uses the same bonding equipment and processes as conventional bonding methods.

Ni-Pd finishes have been used for more than a decade and have proven to be very reliable on interconnect package leads and separable interconnecting sockets. The move to Ni-Pd bond-pad plating at the wafer level is a natural progression for semiconductor packaging.

This technical note discusses the advantages of Ni-Pd bond-pad plating and explains bonding techniques using conventional bonding equipment.

Wire Bonding Basics

In high-volume manufacturing, the process used to form the Al-Au metallic bond is called thermosonic bonding. Thermosonic bonding uses a combination of thermocompression with ultrasonic energy to bond two materials without the need for high temperature. Although some heat is generated, thermosonic bonding typically occurs at temperatures hundreds of degrees below the melting point of the materials being bonded.

Two phenomena associated with conventional thermosonic bonding using Al bond pads and Au wire are intermetallic growth and Kirkendall voiding. When Ni-Pd bond pads are used with Au wire, these two phenomena are eliminated, creating a more reliable bond (see Figures 1 and 2 on page 2).

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Figure 1: Au Wire Bond on Ni-Pd Bond Pad: 1,008-Hour 150°C Aging

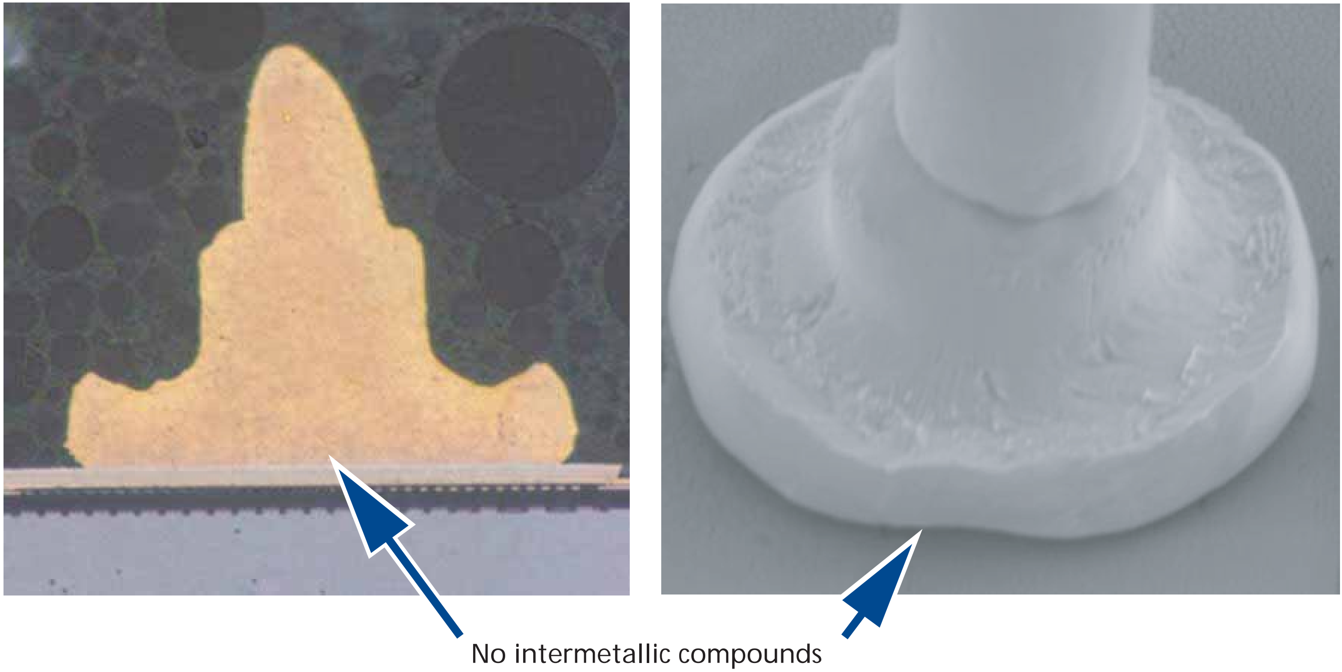
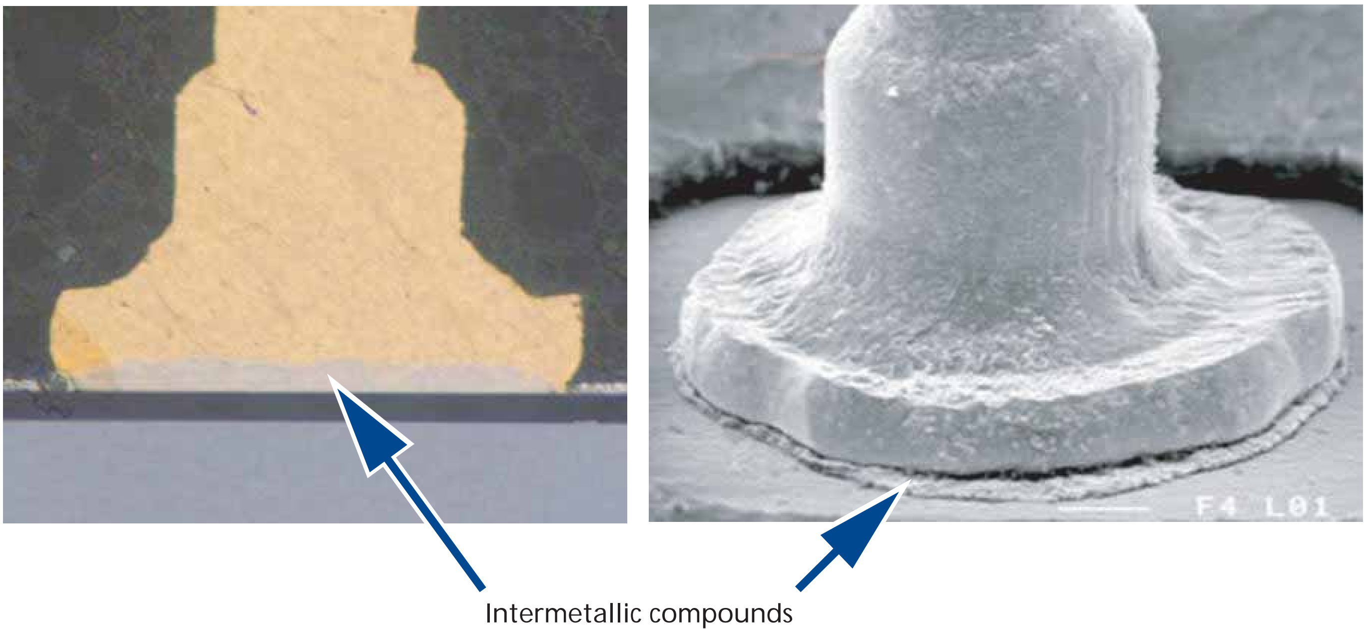


Figure 2: Au Wire Bond on Al Bond Pad: 1,008-Hour 150°C Aging



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Manufacturing Guidelines

Conventional wire-bonding equipment and techniques can easily be used with Ni-Pd bond pads. The thermosonic bonding process is virtually the same as for Al bond pads (see Table 1). The only differences are the USG prebleed requirement for Ni-Pd and the possible increase in time to form the bond.

Table 1: Example of Bonding Parameters

Bond Pad Material	Ni-Pd	Al
Wire type	23µm 99.99% pure Au	
Platform bonder	Ball bonder	
Finished ball diameter	50–60µm	
Finished ball thickness	7–11µm	
Tip offset	127µm	
Constant velocity	0.3 (0.3–0.4) mil/s	
Ultrasonic generator (USG) profile	Ramp	
USG current	110–140mW	
Force	18–25 grams	
Ramp-up time	10ms	
Time	7–10ms	7ms
USG pre-bleed	10–25%	0%

For any wire-bond interconnect system, the quality of the bond pad surface is key to achieving an acceptable non-stick-on-pad (NSOP) rate. Even small amounts of bond-pad contamination can significantly impair the bonding process.

To maintain bond pad integrity and to remove upstream assembly process contamination, Micron recommends that a direct argon (Ar) gas flow without oxygen (O_2) be used; and whenever possible, to only bond to Ni-Pd bond pads once.

Studies indicate that an Ar plasma with O_2 can cause bonding surfaces to oxidize, so O_2 use is not recommended. Studies also indicate that prolonged Ar plasma flows are unnecessary and may result in the redepositing of organic residue on bond pads that are exposed for longer than 30 seconds; therefore, Ar plasma preclean for 10–20 seconds is recommended (see Table 2).

Table 2: Example of Plasma Clean Parameters

Package Type	FBGA	TSOP
Power	300W	400W
Time	20s	35s
Pressure (approximate)	200 mTorr	200 mTorr
Gas 1 (Ar)	60 sccm	70 sccm
Gas 2 (O_2)	0 sccm	0 sccm

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Conclusion

Micron has determined that with proper manufacturing control and only minor modifications, customers can obtain a more reliable thermosonic bond by using Ni-Pd bond pads with Au wire instead of conventional Al bond pads with Au wire.

8000 S. Federal Way, P.O. Box 6, Boise, ID 83707-0006, Tel: 208-368-3900
prodmktg@micron.com www.micron.com Customer Comment Line: 800-932-4992
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Revision History

Rev. B 5/07

- "Manufacturing Guidelines" on page 3: Added caution to avoid bonding Ni-Pd bond pads more than once.

Rev. A 12/06

- Initial release.

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